N90-28240

SATELLITE-DERIVED CLOUD AND RADIATION FIELDS OVER THE MARINE STRATOCUMULUS IFO

David F. Young
Aerospace Technologies Division, Planning Research Corporation
Hampton, Virginia 23666

Patrick Minnis and Edwin F. Harrison
Atmospheric Sciences Division, NASA Langley Research Center
Hampton, Virginia 23665-5225

1. Introduction

The Geostationary Operational Environmental Satellite (GOES) is the only source for nearly continuous areal coverage of clouds within the California marine stratocumulus region. This paper presents a summary of the cloud parameters derived from GOES data during the First ISCCP Regional Experiment (FIRE) Marine Stratocumulus Intensive Field Observations (IFO).

2. Data and Methodology

Hourly, 1-km visible (VIS, 0.65μm) and 4x8-km infrared (IR, 11.5μm) data from GOES-West (135°W) were analyzed with the hybrid bispectral threshold method (HBTM) of Minnis et al. (1987) on a 0.5° latitude-longitude grid which includes the area between 36°N and 28°N and 115°W and 125°W. This grid encompasses the locations of most surface and aircraft operations during the IFO. Data were analyzed for the period July 1-19, 1987. Missing data occurred for entire 24-hour intervals during July 5, 10, and 16. Other sporadic data dropouts reduced the available data to 13 - 16 days for a given hour. Some navigation problems were also encountered, so these results are considered to be preliminary. The VIS data were converted to narrowband reflectance using the calibration of C. H. Whitlock (1988, personal communication). Vertically integrated liquid water content (LWC) was derived from the cloud albedos using the regression fit to microwave data derived by Minnis et al. (1989a). Cloud-top altitudes and surface temperatures for the GOES-West results were estimated from the cloud-top temperature and clear-sky temperatures in the manner described by Minnis et al. (1989b). GOES-East (75°W) 3-hourly, 8-km VIS and IR data were analyzed in the same fashion for July 2-19 except that a 2.5° grid was used. The grid overlays the area between 10°N and 40°N and 110°W and 145°W. Poor spatial and temporal sampling was encountered in the southwestern portion of the grid. High viewing zenith angles reduce the quality of the results in the northwestern corner of the area.

3. Results and Discussion

An overview of the mean cloud amounts is shown in Fig. 1 for (a) GOES East and (b) GOES-West. The average total cloudiness is nearly the same for both satellite views as seen in Fig. 2. Generally, the mean cloud amounts within the IFO area ranged from 60 to 90% with steep gradients near the coast. The diurnal variations of total cloudiness are also very similar for the two views as seen in Fig. 3 for a 2.5° region centered at 31.3°N, 118.7°W. Figure 4 gives the mean diurnal variations of total cloudiness for all 0.5° regions viewed from GOES-West. These "mini-plots" were derived from 3-hourly averages with missing data filled by linear interpolation.

Thus, the curves are smoother and the extrema have been diminished compared to the observed cloud amounts (e.g., Minnis et al., 1989a). The diurnal ranges are greatest along the coastal regions. Cloudiness is relatively constant south of San Nicolas Island (SNI) between the coast and 123°W. Further west, the diurnal range increases again. According to the GOES-East results (Young et al., 1989), this increase in the diurnal range continues to at least 145°W. Clear-sky and cloud-top temperatures are presented in Figs. 5a and 5b, respectively. The gradient in cloud-top temperature is primarily from west to east, while the ocean clear-sky temperature varies from north to south west of 120° and west to east eastward of 120°W. Mean cloud-top altitudes (Fig. 6) range from 450 m northwest of SNI to values greater than 750 m near the southwestern corner of the area. Average cloud-top altitude for the entire area is ~ 600 m. The mean cloud albedos given in Fig. 7 translate directly to LWC in Fig. 8. Maximum values of mean daytime LWC exceed 80 gm^{-2} in the vicinity of SNI. Liquid water contents decrease westward to a minimum of less than 30 gm^{-2} near 35 °N.

The results presented here summarize a much more detailed hourly data set. Some of the parameters have been derived from relationships developed from combinations of other FIRE data. Others were verified using various FIRE data sets. Therefore, the derived parameters should be consistent with other IFO data sets. In general, the results are not greatly different than those found during previous years (Minnis et al., 1988). Thus, it appears that the IFO period is relatively typical of California marine stratocumulus during July. East-west gradients in cloud-top height, diurnal cloud variations, and LWC, however, suggest that the IFO region may not be typical of stratocumulus over the open ocean.

REFERENCES

Minnis, P., E. F. Harrison, and G. G. Gibson, 1987: Cloud cover over the eastern equatorial Pacific derived from July 1983 ISCCP data using a hybrid bispectral threshold method. J.Geophys. Res., **92**, 4051- 4073.

Minnis, P., E. F. Harrison, and D. F. Young, 1988: Extended time observations of California marine stratocumulus from GOES for July 1983-1987. FIRE Science Team Workshop, Vail, CO, July 11-15, 195-199.

Minnis, P., C. W. Fairall, and D. F. Young, 1989a: Intercomparisons of GOES-derived cloud parameters and surface observations over San Nicolas Island. Presented at FIRE Annual Meeting/ASTEX Workshop, Monterey, CA, July 10-14.

Minnis, P., D. F. Young, R. Davies, M. Blaskovic, and B. A. Albrecht, 1989b: Stratocumulus cloud height variations determined from surface and satellite measurements. Presented at FIRE Annual Meeting/ASTEX Workshop, Monterey, CA, July 10-14.

Young, D. F., P. W. Heck, P. Minnis, and E. F. Harrison, 1989: Marine stratocumulus cloud parameters from GOES during the 1987 FIRE Intensive Field Observation period. Proc. AMS Symp., Role of Clouds in Atmospheric Chemistry and Global Climate, Anaheim, CA, Jan. 30-Feb. 3, 178-180.

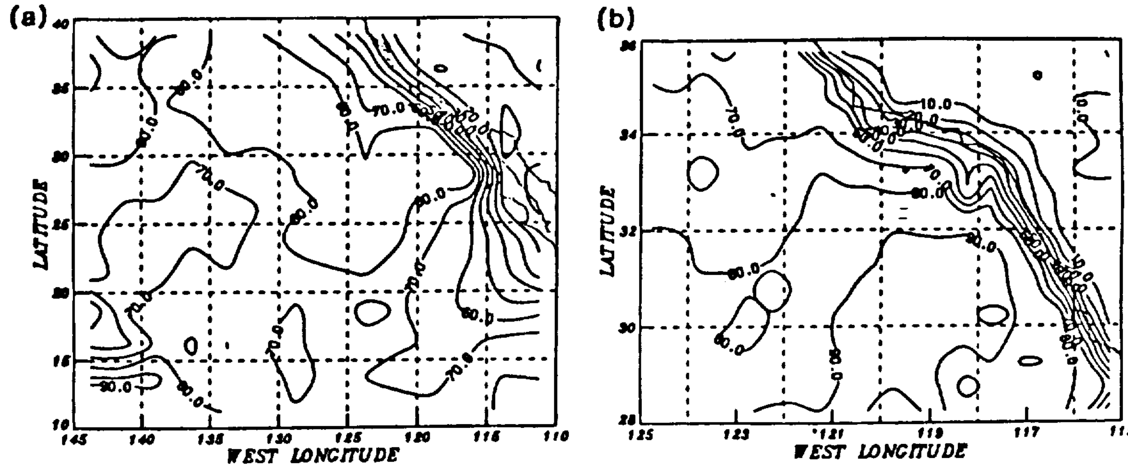

Fig. 1. Mean cloud amount (%) for July 2-19, 1987.

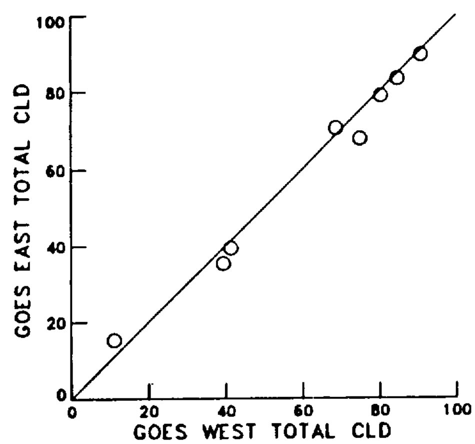

Fig. 2. Correlation of IFO mean cloud amounts for 2.5° regions.

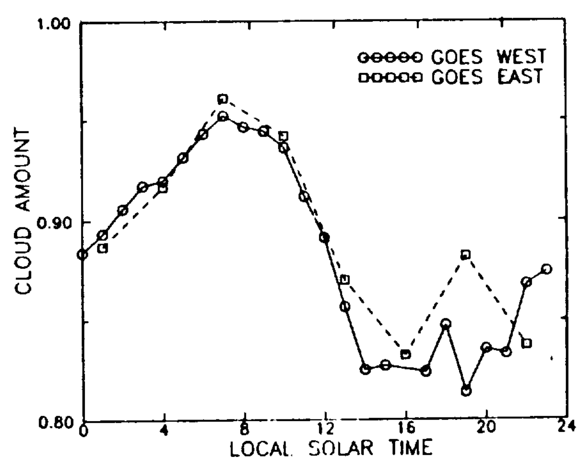

Fig. 3. Mean IFO cloud amounts for 2.5° region centered at 31.3°N, 118.7°W.

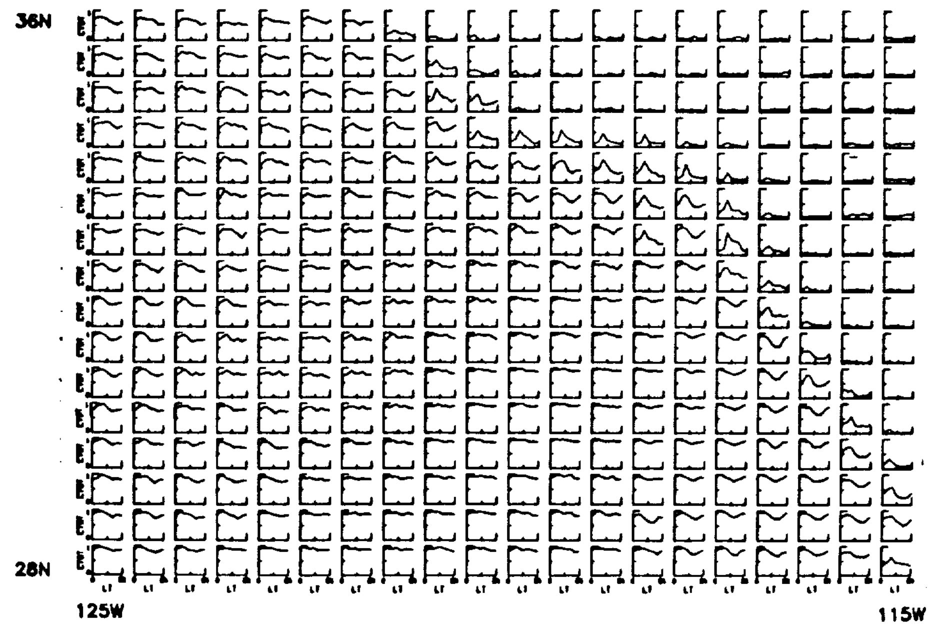

Fig. 4. Mean 3-hourly, GOES-West IFO cloud amounts for all 0.5° regions.

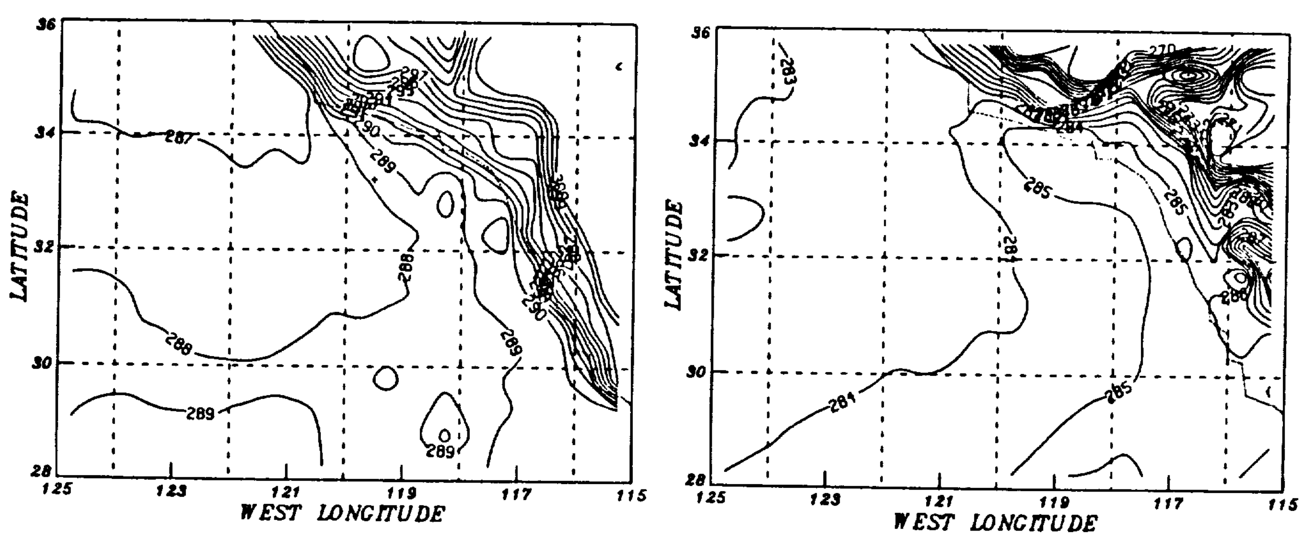

Fig. 5. GOES-West-derived equivalent blackbody temperatures (K) for IFO.

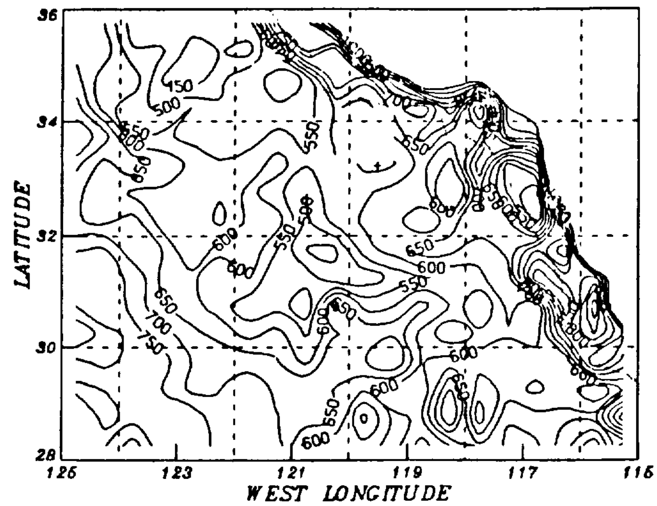

Fig. 6. Mean cloud-top altitudes (m) from GOES-West IFO data.

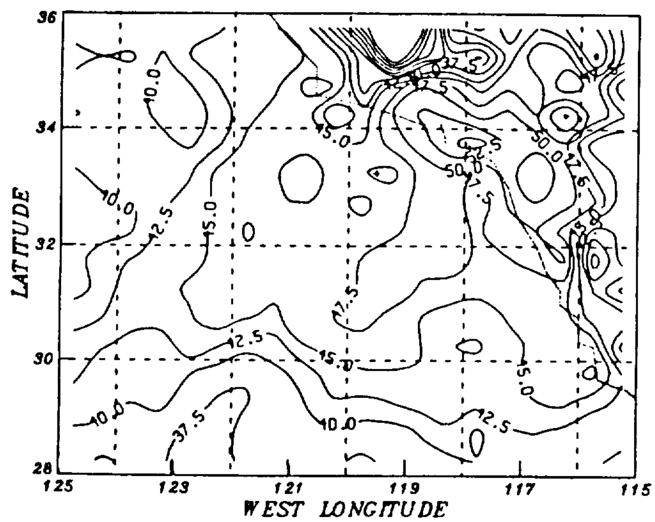

Fig. 7. Mean IFO visible cloud albedos (%).

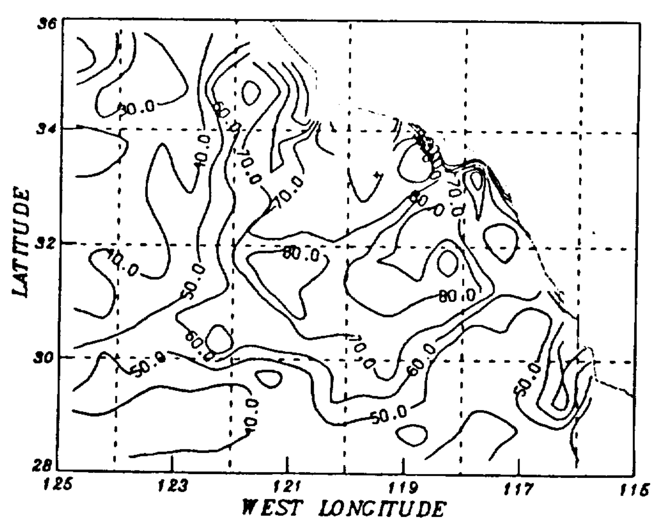

Fig. 8. Mean IFO daytime cloud liquid water content (gm^{-2})